New Methods for Improving of the Product Quality in the Automotive Industry

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Abstract

Contribution shows the existence of a revolutionary solution to the localization of noise emissions and their quantitative evaluation with the frequency analysis in dynamic mode. In the work the mentioned software (Scan & Paint) and hardware (PU probe mini Microflown) equipment can effectively locate sources of noise, perform qualitative and quantitative analysis and create a basis for soundproofing products and machinery.

Keywords

Microflown; Visualization; Acoustic Intensity; PU Mini Probe; Acoustic Particle Velocity

Introduction

From experience, we know that noise problems in indoor environments are usually very complex. This is because that the acoustic field in the interior has a very high index of the pressure and intensity (because of a number of sources and their reflections are the acoustic pressure high compared to the intensity of sound). From received informations it is clear that with the traditional pp intensity acoustic probe is difficult to measure for example, interior of the vehicle. For this type of measurement, the probe PU mini Microflown is completely adapted. On the measured stationary object (engine of passenger car Ford Fiesta) was observed by the emitting sound at different frequencies in different frequency ranges.

Methods to Visualization of Noise

Localization of the sound source is a challenging task. At present there are several standard methods (Fig. 1.) Although these methods have undergone a fundamental constant improvement, the problem remains that there is no universal technique to localize a sound source, which takes precedence over the others. It is always necessary to choose the method according to the nature of power, space, and information that we obtain the method used.

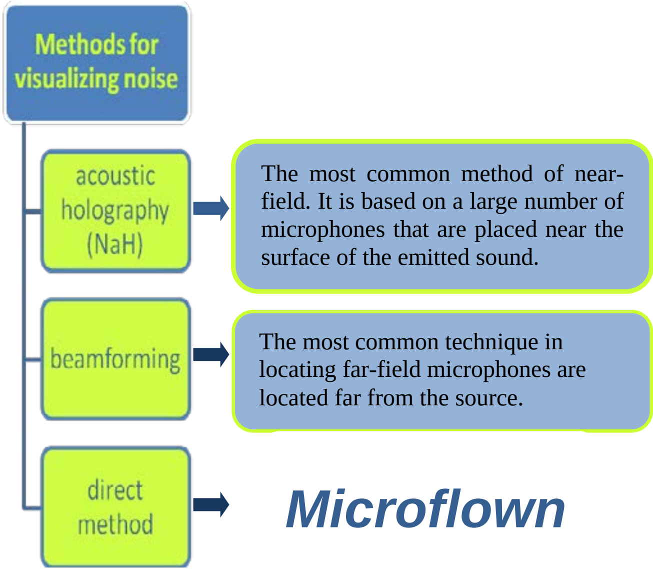

FIG. 1 METHODS FOR VISUALIZING NOISE

When choosing the most appropriate method to locate the sound source, it must be considered in the following criteria:

The above-mentioned criteria for selecting the location of the sound source are taken into account in the following measurements.

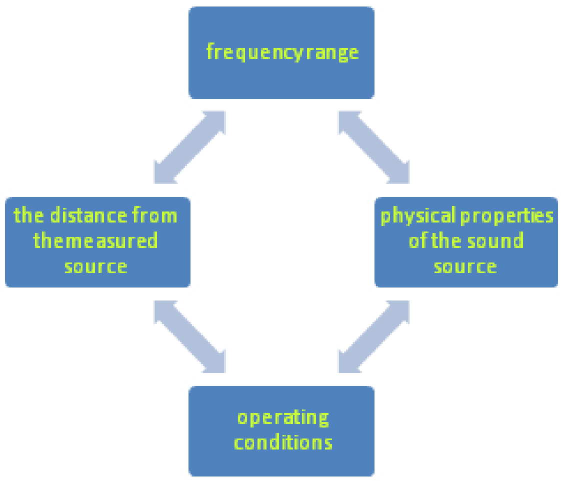

FIG. 2 IMPORTANT CRITERIA SELECTING A SUITABLE LOCALIZATION OF SOUND SOURCE

Application of Microflown

The Microflown is a particle velocity sensor that is based on a thermal principle. It consists of two very closely spaced and thin wires of silicon nitride with an electrically conducting platinum pattern on top of them (Figure 3). The sensor is made from silicon bulk material with platinum electrical connections on top of it and two platinum temperature sensors. At the top, one can see two sensors sticking out. The electrical connecting wirebonds are also visible. The metal pattern is used as temperature sensor and heater. The sensors are powered by an electrical current, causing the sensors to heat up. The temperature difference of the two cantilevers is linear dependent on the particle velocity level.

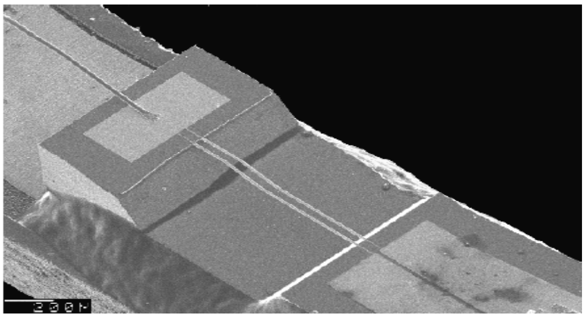

FIG. 3 CONNECTED AND GLUED WIRES ON THE PRINTED CIRCUIT BOARD

The advantage of measurements using the Microflown system is that the background of the acoustic field is suppressed and the acoustic field of the surface is more intensive. This function is very helpful for the techniques of localization of noise sources in real environment when it is not possible to put technical appliances out of operation – sources of noise located in the surroundings.

PU Mini Probe

The PU probe (Figure 4) is a general purpose sound probe that measures both particle velocity and sound pressure. The probe has a gain of about 15 dB (for the particle velocity only) causing an improvement of the selfnoise of about 15 dB. Since the packaging upper sound limit is also 15 dB lower due to the packaging (128 dB). At higher frequencies (f < 10 kHz) the ½”. Figure 4 shows schematic illustration of the proposed procedure of using the PU intensive mini probe for application of this technique in the teaching process.

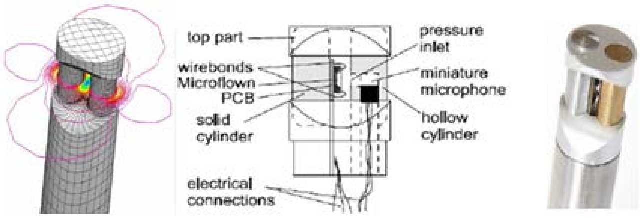

FIG. 4 CONNECTED AND GLUED WIRES ON THE PRINTED CIRCUIT BOARD

Selection of the Measured Object

The choice of the measured object, the passenger car was based on the increased demands placed on this type of product, whether it is the higher comfort requirements of travel, or smaller load requirements of ambient noise emissions. Finally, the method is suitable for the specification of noise sources with design solutions and requirements for this type of product. The mentioned passenger car as the subject of experimental work has become a strategic product in our country in recent years. Slovak economy and its gross domestic product is dependent on the manufacturing sector, the automotive sector, as evidenced by the fact that our country has in recent years become one of the largest car manufacturers in Europe. The production after a recent slump enjoys substantial revival, as it indicating the assumption for 2013, whereby it could be produce about 800 thousand cars together in three Slovak car factories. The selection of the measured object was also due to this fact nowadays hot topic.

The Figure 5 shows the measured object with the appropriate assembly required to measure, consisting of a laptop, MFDAQ - 2, web camera and color-coded intensity PU mini probes.

FIG. 5 ASSEMBLY FOR MEASURING

Measurement Procedure

The task is to identify the sources of noise in complicated technical equipment such as car engine. The processing data is done using Scan&Paint software. Below is given a description of a

measurement of the engine of a Ford Fiesta, made in 2002, engine performance 40 kW. That measurement performed as the engine was running at revolutions of 1500 per minute (Figure 6).

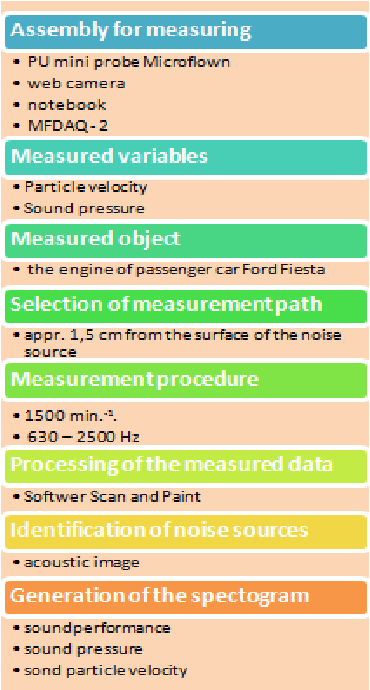

FIG. 6 INSTRUMENTS, VARIABLES AND METHODS OF MEASUREMENT

Selection of Measurement Path

The measurement was carried out in the distance of appr. 1,5 cm from the surface of the noise source – combustion engine. Microflown which is implemented in the PU mini probe is directional. It means that orientation of the PU mini probe while scanning the engine was of importance. The PU intensity mini probe was oriented in such a way that while the scanning Microflown was in the perpendicular direction in relation to the measured object. Green-coloured labelling was used for detection of the PU mmini probe in space using Scan&Paint software for scanning of the measurement path. (Figure 7).

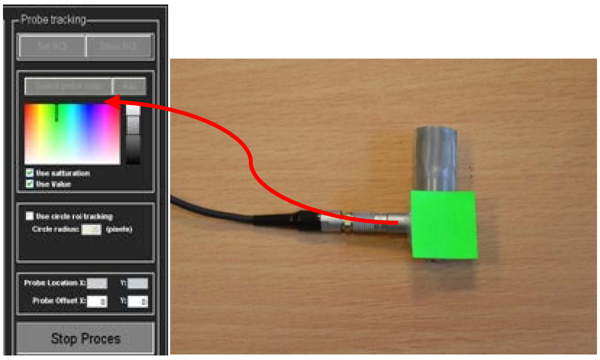

FIG. 7 LABELLED PU MINI PROBE

The engine surface was scanned using the Microflown PU mini probe while the camera was installed on the car hood in the direction to the surface emitting sound. After recording the video and audio, the synchronized data were processed. The whole measurement (scanning) in this case took 1 min. and 48 sec. (Figure 8). In order to visualize the probe trajectory, it is necessary to generate an image from each video from which the position of the probe is extracted. The above-mentioned colour labelling of the probe (green) was used for detection of the position of the probe.

Processing of the Measured Data

Downloading and processing the measured data is at the time interval of several seconds. Velocity, intensity and pressure are recalculated from the proportional time block of the acoustic data at each measuring point.

Identification of Noise Sources by Generating an Acoustic Image

The result of the measurement is a coloured acoustic image. An acoustic film allows listening to and watching the measurement that was performed. A video is created using an external camera. The cover on the PU mini probe reduces the influence of the unfavourable surrounding conditions (wind, airflow), mainly at higher frequencies. Measurement is carried out in 1/3 octave bands. When measuring, the required acoustic quantity can be chosen (in this case it was sound intensity, acoustic particle velocity and acoustic pressure) with the corresponding image of the acoustic map for each quantity followed by recognition of the path of the PU mini probe in the software and generation of an acoustic image. The abovementioned acoustic quantities were assessed in various frequency bands and ranges along with monitoring the engine noise emitted in different frequencies. Figure 8 shows the acoustic image of the whole trajectory of the PU mini probe at the frequency range 630 – 2500 Hz. The most significant sources of sound shown in Figure 9 can be identified from the time courseat on acoustic image (Figure 8) of revolutions (1500 rev./min.).

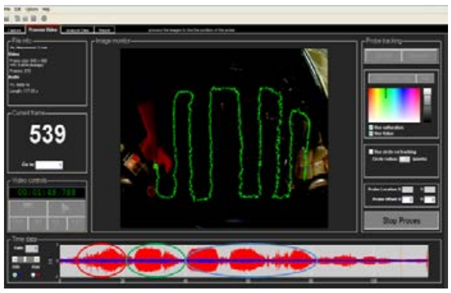

FIG. 8 IMAGE OF THE WHOLE TRAJECTORY OF THE PU MINI PROBE

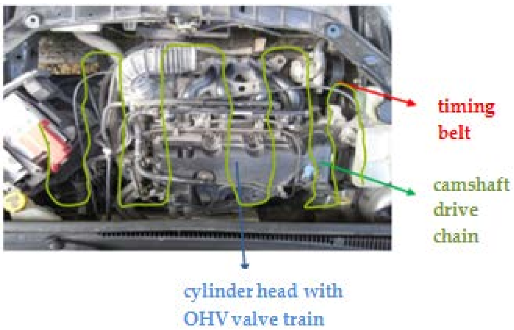

FIG. 9 ACOUSTIC IMAGE OF THE ENGINE ACOUSTIC INTENSITY (630 – 2500 HZ)

Generation of the Spectogram of the Whole Scanned Object (image)

Figure 10 shows an acoustic image of sound pressure generated at the frequency range 630 – 2500 Hz.

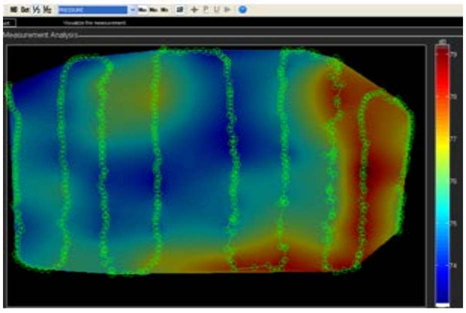

FIG. 10 ACOUSTIC IMAGE OF THE ENGINE ACOUSTIC PRESSURE (630 – 2500 HZ)

Six of the distinctive sources of sound are visible in Figure 11 at revolutions (1500 rev./minute) from the acoustic image, which are (1) camshaft drive chain (below the lid), (2) oil pump, (3) water pump, (4) alternator, (5) timing belt and (12) ventilator.

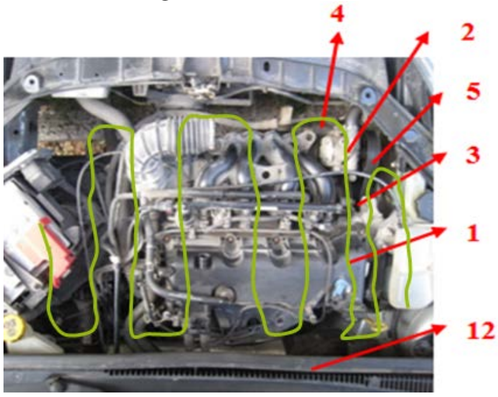

FIG. 11 ACOUSTIC IMAGE OF THE ENGINE ACOUSTIC PRESSURE (630 - 2500 HZ)

Figure 12 shows the spectrum of the total sound pressure.

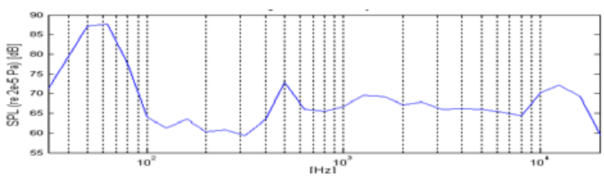

FIG. 12 SPECTRUM OF THE TOTAL SOUND PRESSURE

Figure 13 shows a generated acoustic image of particle velocity at the frequency range 630 – 2500 Hz. The assumed sources of sound are (10) engine firewall (12) ventilator.

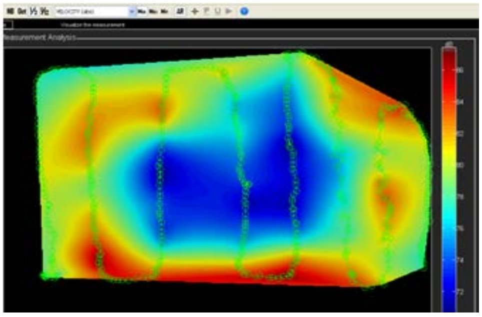

FIG. 13 ACOUSTIC IMAGE OF THE ENGINE ACOUSTIC PARTICLE VELOCITY (630 – 2500 HZ)

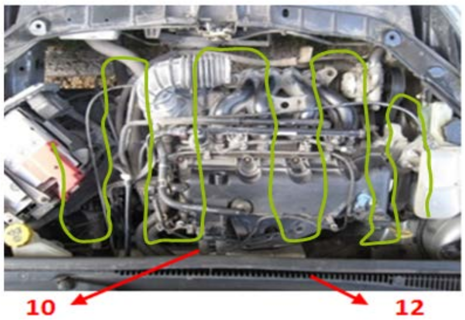

FIG. 14 ACOUSTIC IMAGE OF ACOUSTIC PARTICLE VELOCITY (630 - 2500 HZ)

Figure 15 shows the generated spectrum of the total particle velocity.

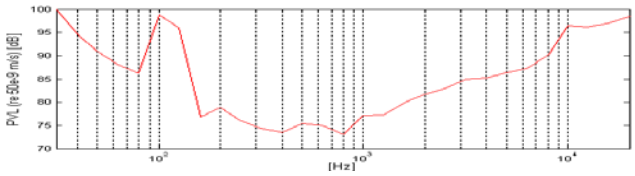

FIG. 15 SPECTRUM OF THE TOTAL PARTICLE VELOCITY

Conclusions

The issue of noise and its impact on the environment is currently the hot topic and is promising in terms of future developments in improving the various components in the automotive industry to what could help the identification of sound sources using equipment Microflown. The methodology applied by the authors of the motor vehicle can be:

- locate sourses of noise, they making a detailed analysis and identifying descriptors of selected acoustic noise sources to get information for the further development of car,
- based on the mapping of acoustic behavior of the engine to evaluate the technical condition - end of line testing manufacturing, or to identify defects during using a car.

This process requires a perfect knowledge of acoustic descriptors, and the importance is mainly the sound pressure, sound pressure level, sound power, acoustic intensity and spectral features of the emitted sound.

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